Six Legged Autonomous Robots for Military and for Civil Use

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Abstract—**The army and the industry use many types of robots; from witch a large part is pre-programmed. However, nowadays a huge number of autonomous robots are constructed for military purposes; witch may also be used for civil purposes. In the development of military robots it's significant, that military robots controlled by the soldiers which are eligible to smite, and military tools for civil application are very limited, while the fight support and logistical tasks robots almost without any modification can be used for civil purposes. In this paper is presented the possible use of six-legged autonomous robots in military and in civil area.**

I. INTRODUCTION

Nowadays engineers use the discourse method of design, a conscious process in which step-by-step are solved the technical problems. The technical problem solution ideas are almost based exclusively of intuition. The solution of the problem is based on the engineer intuition and in his accumulated experience. The most comprehensive „experience collection" is found in the nature, because in the course of millions of years has arisen many problems, for which some solutions always were evolved.

II. WHY SIX-LEGGED ROBOTS?

As a result robots designed for military and civil tasks in the general approach are wheel rolling vehicles, but the research of walking robots are significant too. The nature shows every pair leg solution from 2-„100".The six-legged robot is one of those groups which are developed, made with these natural patterns.

Antrophods are one of the earliest multicellular animals and the most numerous ones. They move with jointed legs. Insects which are subspecies of anthropods are classified in the family of hexapods (Hexapoda is the translation of the Greek word „six leg"), and they have the greatest number of species

So, for the row hand question, the nature gives the answer: when insects move from 3 pairs of leg 3 always in the ground, and because 3 point defines a plane they are always stable.

III. THE MILITARY LOGISTICS AUTONOMOUS GROUND ROBOTS.

There are a variety of robot's definitions. All definitions highlights those features of the robots that they are able to make complex tasks in pre-programmed mode or remotely. Robots used in factories works in a well defined environment and in their adaptation to the environment; they only indicate deflection with their sensors in the usual environment than the robot will stop as soon as possible after operator instruction or waits for the termination of the interfering signal. It shouldn't attempt to give a solution or to eliminate this confusion. Some modern factory robots are autonomous within the strict limits of their environment.

Contrarily, autonomous robots have the property, that without constant human control, they can also implement desired tasks in previously not defined environment too. The research field of robots aims the fact that robots be able to recognize the environment and to perform data processing tasks, in such way to follow up the opportunities offered by the nature and to avoid dangers from the environment.

An autonomous robot is capable to:

- obtain information from its environment;
- work without human intervention for a long period;
- move without human intervention;
- avoid situations which are dangerous for people and for the robot too;
- learn the possible movements;
- adapt to the environment during the operation.

Military robots can be sort by the ability of adaptation to the environment, namely by the respective environment characteristics (see Gácser), so we can distinguish:

- land robots;
- aeronautical robots (fixed and rotary wing flaying tools without a pilot);
- space robots;
- water, underwater robots;
- amphibian robots (here come under tat tools which can move in ground, water, underwater).

Nowadays the army's digital, precision and network development is characterized by a significant change, which we call military robot revolution. [2] Every army use in a growing number for different tasks and with martial ability, first generation of land, aeronautical and marine robots.

Because of the effect of market interest, different types of robot tools are available, with numerous sub-types [for details see 3]. In military application logistic land robots takes part in the family of land robot vehicles.

IV. SIX LEGGED ROBOT MOVEMENT

The six legged robots move exactly like insects-moving their legs. This movement can be applied in difficult terrain such as during military operation where it is important, where the stability of the transportation is essential. In this terrain wheeled vehicles cannot be used.

The principle of moving –the six leg steps – is very simple, but it can be a difficult task to keep the right direction and in one line.

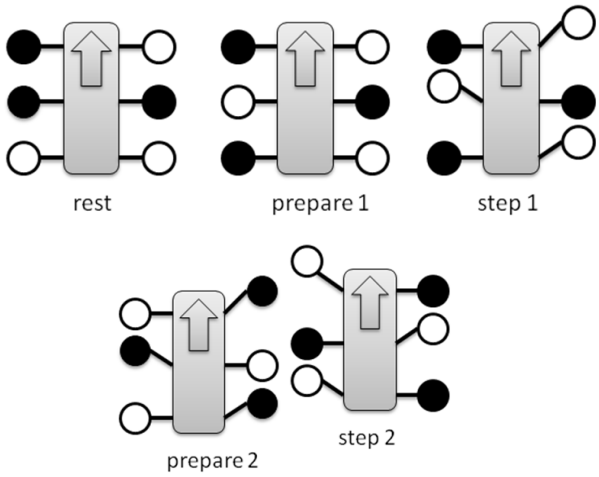

Fig 1. sample biological tripod gait

In figure 1 –marked with black circle- it seems that in each case 3 legs ensures the stability, keeps the robot and the weight of the load. The other three legs prepares for the next move, taking up a new position. (phase prepare 1 then step 1). This new position will be the stable condition for the next step cycle (phase prepare 2). In difficult terrain the robot is capable to value the stabile states, and if it is necessary to take a decision in order to choose the stable right stabile condition. In „no moving" condition the robot legs touch the ground and 3 of them, which are not in the same snide, „carry" the weight. (status rest).

Beside others Full and Meijer [3] developed the principle of place changes, of the six legged robots, based on biological samples and compared with other options. In virtue of their results I consider that in six legged movement, the following functions can be assigned to the leg pairs:

- the under direction first two legs, in addition to change their direction they must occlude the collision and they also have to create stability;
- the under direction back leg pair mostly gives the necessary power to the forwardness and can also participate in the direction change;
- the middle legs ensure the combination drive and gives stability.

Due to the stability, which is similar with an insect, it can be used in terrain where the transportation is difficult with wheels in case if legs are not under the structure of the robot but they sprawl on the ground. These expanded postures significantly increase the stability and reduce the chance of an catastrophic fall.

However to create a six legged robot is expansive, not a negligible criteria is that it increase the energy supply, so next to the useful load, it carries the energy source. Legs can also be used for other functions; such like in different situation they can operate like arms, in loading cases; in other cases legs can be equipped with sensory functions.

So, the terrain moving robot can perform two functions: to manoeuvre and to make manipulative activities. With traditional manipulators and with four- legged robots this effect cannot be reached, because the mechanism of the manipulators weren't designed to be able to move itself. The best application it seems to be the so called "limb mechanism". In the limb mechanism there are integrated in one limb the structural components which are responsible for the manipulation functions and for place changes. It is able to move in any direction and to provide manipulation tasks with its limbs.

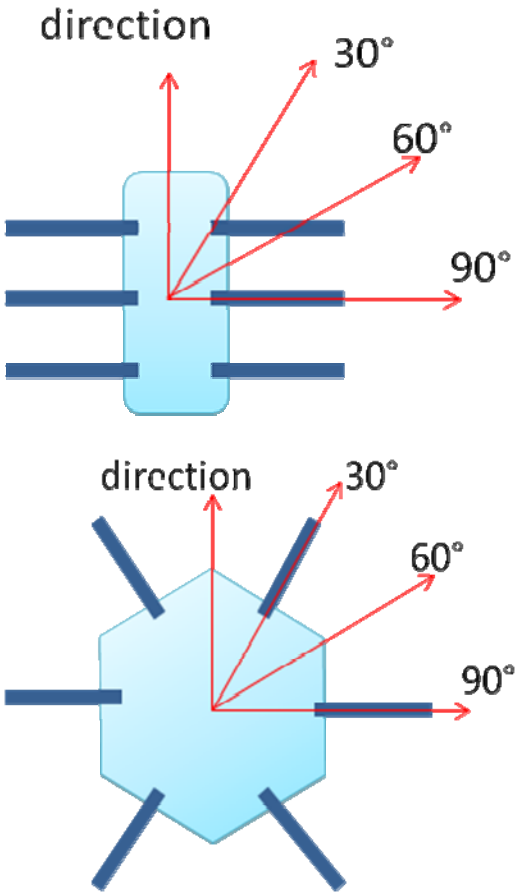

Fig. 2 a, Parallel leg arrangement
b, Radial leg arrangement

Figure 2 shows two-foot locations: left side is parallel leg arrangement, and in the right side is presented the radial leg arrangement.

There are many analysis with the six-legged solution [4, 5], and it was concluded that the movement of radial leg arramgement direction change capability is better, than the parallel leg robots, the sability doesn't decrease. It is a problem to calculate the position of certain limbs, and to define the occupied new position (for example: slip, positioning errors) in order to the next step.

For military and for civil use six-legged robots, wich moves in difficult terrain, the two principles of their desig are: to move quickly and to protect the load. For this the robot has to select with the help of its sensors the stable points for the movement, because without using such one leg the robot can fall over. The robot can become instable even when he doesn't use its two legs which is side by side, but it tooks from the ground and uses for manipulation. To avoid this situation must be developed a strategy of „walking"- it may be suitable the movement presented in Figure 1 – and the sensor and intervention systems.

The construction principles of six-legged robots which are eligible for military and for civil use

The University of Debrecen, Faculty of Engineering, Mechatronics and Electronical Enginnering Department's students and professors, decided to build a six-legged robot, which will be suitable for macro sized robot modelling for load trasportation in difficult terrain. The designed six-legged robot meets the following requirements:

- the main aspects of mehanical design of the robot is the portability; but it must be maximalized the clear capability which arise from the size and weight;
- the robot's legs will be placed in radial arrangement, as it can be seen in Figure 2 .b, ensuring a high stomach tallness to creat the overland capability;
- each leg must be three degrees of freedom structure;
- the energy concentration in the case of combustion enginers is the highest, the robot will be electric-powered, the energy source is a producted battery;
- all joint must be controlled separately, this means in total for six legs 18 co-ordinated control, we will make te co-ordination with PLC as Kucsera [6.] recomands.

The 18 control needs a high-performance computer, which must be carried by the robot, incrasing the weight. To avoid this, the robot must be operate with distance control, respectively it sholud be used the symmetric repetition of walk. Because 3 legs are always in the ground and ensure the stability, maximum 3 legs can move in the same time. It makes easer the creation of the control, that the moving legs field in many cases are symmetric or rather can be obtain with 60 degree slew.

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V. SUMMARY, CONCLUSION

In the development of mobile robots a somewhat overshadowed possibility is the „walking" robot development In the case of 2 legged robots, the biggest problem is to maintain the sability, with more legs the stability increase significant, but the control is more complicate. This article summarize the principles of robot construction, which carries useful load in difficult terrain. This robot it is under building in the University of Debrecen, Faculty of Engineering.

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